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Paper of Dr. D. Prince upon Atmospheric Purification in Relation to Infectious Diseases; Presented to the American Public Health Association.

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AN EXPERIMENTAL STUDY

IN RELATION TO THE

Removal from the Air of the Dust or Particulate Material Supposed to Produce Yellow Fever, Small Pox and other Infectious Diseases.

The study of the subject in relation to the purification of the air from the particulate material causing, in wounds, putrefaction, erysipelas and hospital gangrene, has led to further thought in relation to general infectious diseases.

The study of a subject for a special application of principles, often opens up to the mind the practicability of arranging the details of methods so as to accomplish other objects than those contemplated in the first endeavor.

The writer of this paper has been for two years making an experimental study of expedients for securing a dustless atmosphere for surgical purposes. It is now generally believed that one of the most important causes of the bad behavior of wounds is the prevalence in the air of floating particulate material, the exclusion of which from wounds is important.

After the discovery of oxygen there came a theory that the decomposition of exudations from wounds and abraded surfaces attended by foul odors and evidently poisoning the system, was owing to the contact of oxygen.

The history of surgery includes the account of many expedients for excluding oxygen upon the supposition that the difference in the behavior of subcutaneous injuries from that of open wounds was to be accounted for by the presence of this or some other gas.

It is not until recently that it has been established beyond dispute, that the infection which is chiefly dreaded is not gaseous, but particulate and capable of being separated from the air in which it floats.

The problem has been to open the abdomen or other part and to keep it open for an hour, if necessary, and on closing it again, to have it in such a condition, as to material floating in the air, as it would be in if all the proceedings had been carried on subcutaneously.

The attempt to reach this desideratum by water filtration has been successful as to those atmospheric agents occasioning putrefaction. It has been found, however, that the germs of mould get through the showers of water to a limited extent. They are the lightest of germs, and develop most abundantly in wet weather and in damp places. The plan by water has been—first, to moisten the air by steam; to carry it next through a shower of water; to heat it by a stove (except in hot weather) and then to carry it through another spray of water.

The first thought was to secure a purified atmosphere for an operating room, but in the progress of experiment and reflection, the plan was improved so as to secure a current of air thus treated, to envelope the wound itself, so that impurities escaping from the occupants of the room could not come in contact with the wound; being blown away by the blast of pure air.

Finding that air cannot be completely deprived of its floating material by water, attention has been given to the devising of a practicable plan for purification by the passage of air through cotton. The capability of cotton of arresting all particulate material floating in the air is a remarkable discovery. Most interesting details of experiments to prove the power of cotton in arresting the agents of putrefaction changes may be found in the *Popular Science Monthly* for February, 1878, page 476, and March, 1878, page 501, in which the observations of Professor Tindall upon this subject are related. The fact that a seal of cotton preserves any kind of material from decomposition, provided that the agents of decomposition are not already in it, shows—first, that these agents are not gases; for anything of a gaseous nature goes readily through cotton; and, next, this fact shows that gases do not initiate decomposition and that particulate material does. This proposition has been so thoroughly worked out by experiment and observation that it is not worth

while to go over the proofs. The work of experimentation with culture liquids is greatly facilitated by this knowledge. The experimenter has only to put a plug of sterilized cotton into the mouth of a test tube containing the liquid under observation, and to subject this liquid to daily boiling for a few times, in order to be sure that it is free from organisms, and he has a liquid under circumstances to keep free from decomposition for an indefinite period.

On the introduction of any infectious material to be experimented upon, he is equally free from the annoyance of the introduction of any atmospheric agent, unless the intrusion takes place at the time of opening the cotton seal.

This is readily seen to be much more convenient of management than flasks hermetically sealed. The same tubes can be used over and over to any extent. The problem for perpetuating the sterilization of stationary or still air, is thus completely worked out. The arrangement for an apartment of many feet in dimensions, is as simple as that for a test tube.

The problem now in hand, however, is to secure the sterilization of air in motion and which can have no boundary wall between it and the ordinary atmosphere.

The use to be made of such air is (1st) to secure to a surface freedom from the influence of septic or pathogenic agencies, at the same time that it is being manipulated for surgical or other purposes; and (2d) to secure for living beings an air to breathe, free from infectious agencies; or to take immediately away, the products of exhalation from the lungs and other parts of the body.

A portion of fruit may be sealed in a can by cotton or by solder, and it will keep indefinitely, but a breathing animal, to be free from septic or pathogenic agencies, when these agencies are round about him, must have some other arrangement, by which his own exhalations may be carried away.

If it is intended, in a particular case, to shield a person from the infection of yellow fever in an infected location, the filtration of the air to arrest the particulate material of the infection, must permit a perpetual change. This is secured in a great degree by respirators, worn upon the face, which are usually made to sterilize the entering air and perhaps might be made to sterilize the air of expiration.

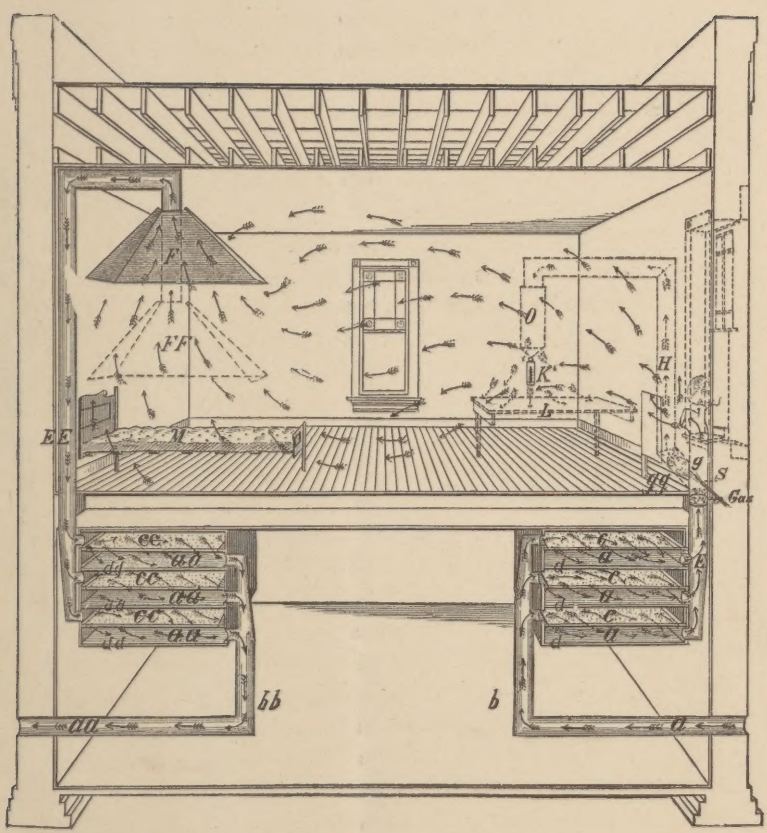
To prevent a subject from taking a disease, the filtration of the inspired air is required, and to prevent his imparting a disease, the filtration of the air expired must be secured.

The endeavor, at present on hand, is to secure an arrangement which may take a company of men in an ordinary room and do for them what the respirator is supposed to do for one man. The suction by the expansion of the chest is a force capable of drawing a sufficient quantity of air through the cotton in front of the lips and the nose; but for the face, respirator, the problem of sterilizing the expired air, has not been worked out, because it would be extremely inconvenient to blow with sufficient force, during each expiration, to propel the expired air through a cotton sterilizer. On a large scale, however, the difficulty vanishes, because it is as easy for a fan to push as to pull.

The device on the one hand for blowing the fire of a furnace, and on the other hand for sucking away the sawdust of a circular saw in a plaining mill, is the finger point toward the arrangement needed. This is an instance in which inventions for particular purposes, become equally valuable for far different ends. In any establishment in which there is an engine, or a motor of any kind, the remainder of the detail may be easily worked out.

The problem is not difficult, if the air is to be stationary, but the circumstances require that a considerable quantity of air shall be supplied and be quickly replaced by another supply, in order that the impurities, generated may be carried away. All know the effect of a hedge or a strip of forest in arresting the force of the wind in the winter, when there are no leaves, but only the filter of limbs.

What these limbs are to the wind, a layer of cotton is to the current of air employed for the purposes referred to. As it is important for surgical purposes that the sterilized air should have a temperature equal to that of the body, while it is comfortable to have the general air of the room much lower in temperature, there arises the difficulty of the tendency of the warm air to rise to the upper part of the room, instead of enveloping the wound of a patient under operation or surrounding a sick man lying upon a couch. It is entirely practicable to secure a sufficient degree of motion by means of heat if there is not the impeding effect of the cotton.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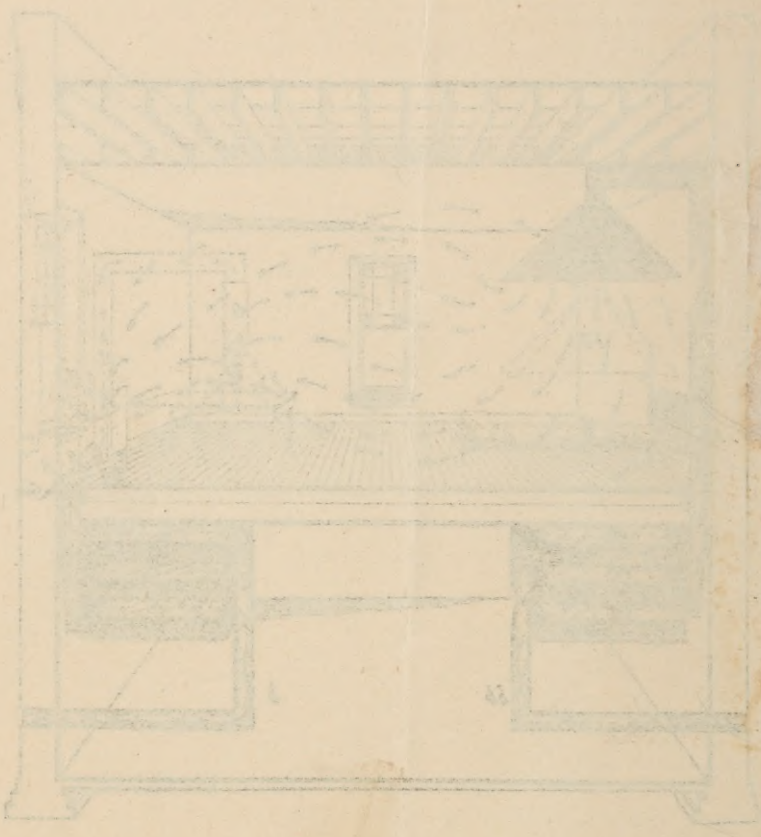

To overcome this difficulty, the force of a fan is employed which is run by an engine. By establishing a hurricane on one side of the cotton, a moderate wind is secured on the other, having a force sufficient to overcome the effect of light specific gravity in the warm sterilized air. For surgical purposes, the addition of a small amount of steam is desirable, in order not to dry the exposed moist surfaces, and an arrangement for that purpose is seen in the drawing.

This figure represents a scheme for sterilizing the air which enters a room for protection against infection, and one for sterilizing the air escaping from a patient who is supposed to be afflicted with small pox or some other infectious disease.

In this scheme the particulate material is supposed to be arrested by the cotton, which, at the end of the necessary period, can be burned.

The arrangement is in the form of a chest of drawers, the outside of the chest being a cube of fifty inches.

There are three drawers, each having an area of cotton 40x40 inches; equal to 1,600 square inches; the area of the three being 4,800 square inches.

There are two air tight floors; one below the upper shelf and one below the middle shelf.

The air enters above each shelf of cotton, and escapes below it. A sheet of woven wire with three-quarter inch openings serves as the support for the cotton, which is about an inch in perpendicular thickness.

For blowing sterilized air into a room, the blower must push. For taking foul air out of a room, the blower must pull.

The arrows show every where the course of the current of air.

Observations are in progress to prove the approximation to perfection, of this device for depriving the air of the material in it, which is capable of starting and perpetuating changes in organic substances.

The value of an expedient like this on ship board must be obvious at first sight. The patient being confined in an appartment, an arrangement may be made to be run by the machinery of the ship, to give him pure air or to purify the air which is poisoned by emanations from him, or both combined.

An experiment to determine the penetrability of cotton by gases while the particulate material is arrested has been made by burning sulphur in the air previous to its passage through the cotton and finding that the sulphur dioxide passes readily through, while the particles which ordinarily give a blue tinge to the sulphurized air, have been arrested in the cotton mesh, leaving the air perfectly transparent.